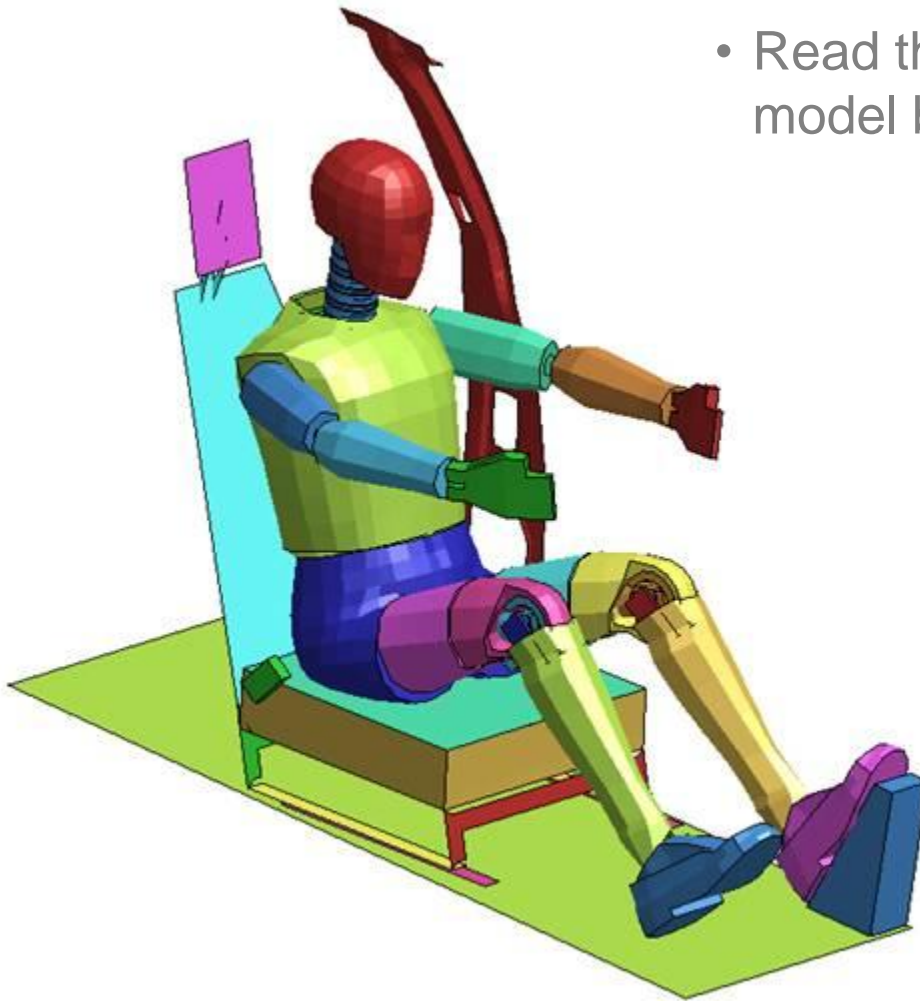


# *Oasys* **LS-DYNA** TRAINING COURSES

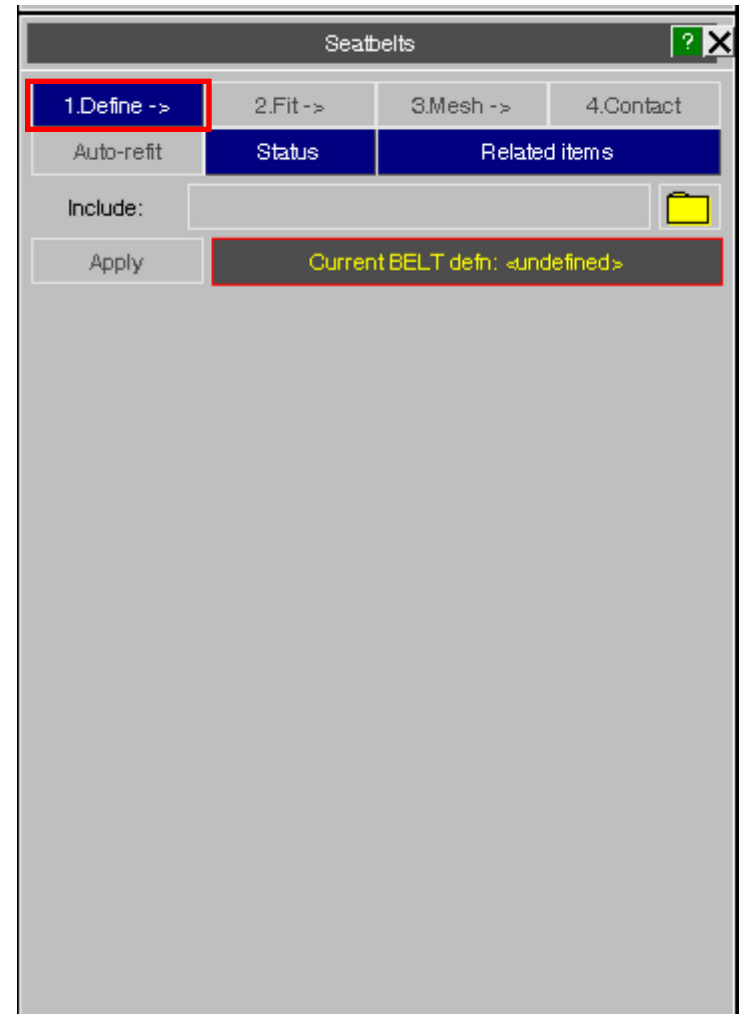
## Oasys 9.4 Seat Belt Fitting

- Read the simple seat and dummy model belt\_fitting.key into PRIMER

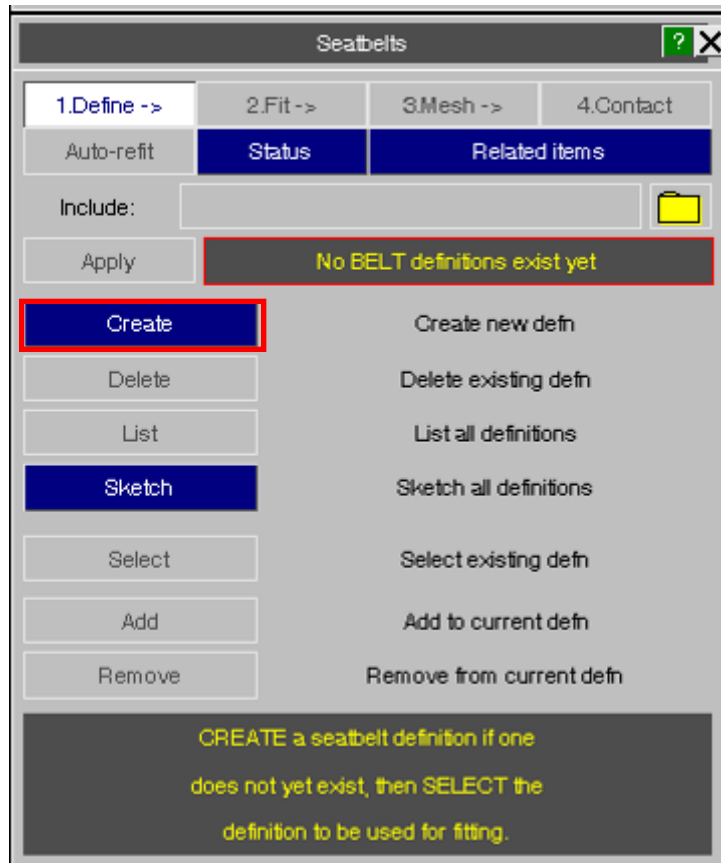


# Belt Fitting

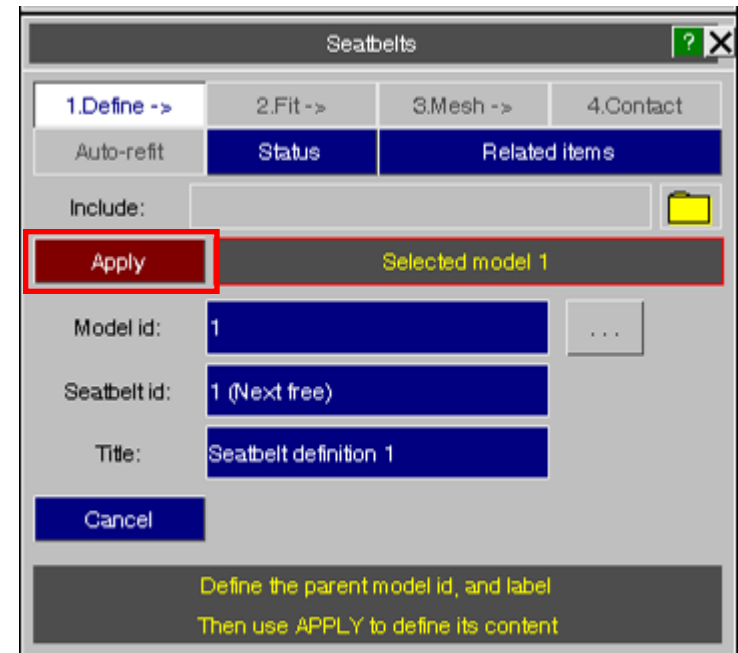
- Tools => Occupants => Seatbelts
- This menu allows you to define and modify a seatbelt definition
- Seatbelts => 1.Define; to start creating a seatbelt definition



# Belt Fitting

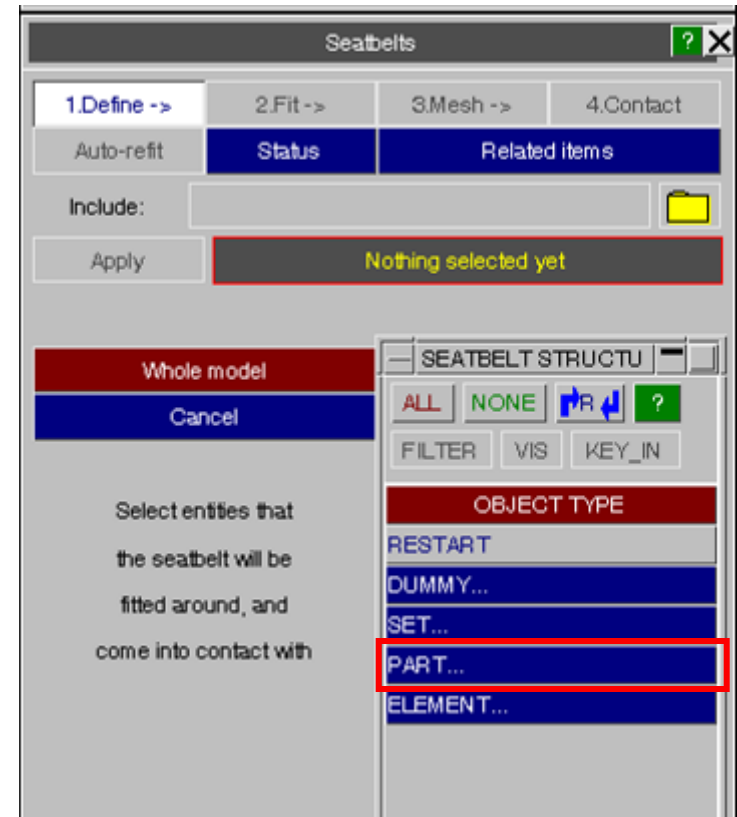
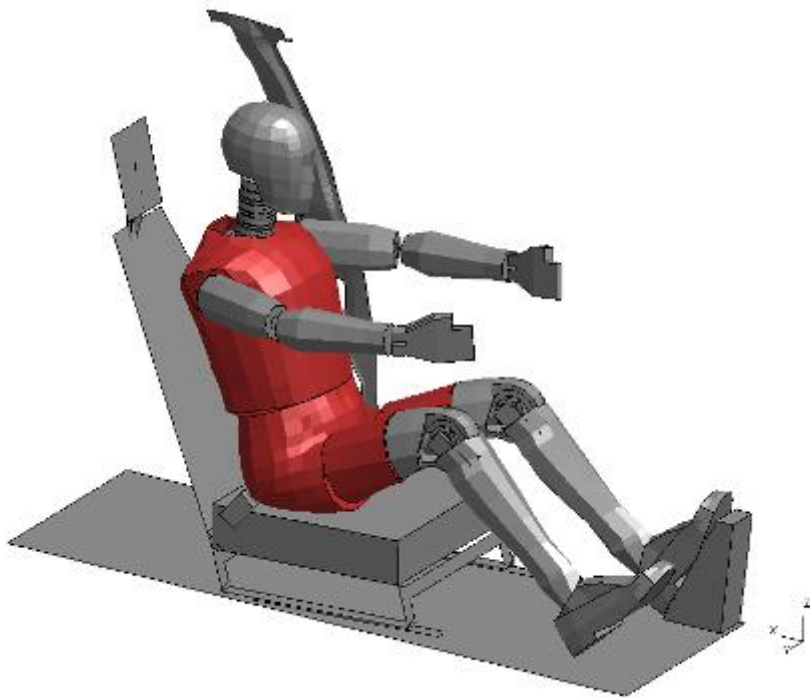


- Seatbelts => Create
- Select the model in which we want to create the seatbelt definition (Model 1) and give the Seatbelt definition an ID and name.
- Press Apply



# Belt Fitting

- Now we need to select the parts around which the seatbelt is to be fitted
- Press Part.. and select the parts shown in red below
- Press Apply



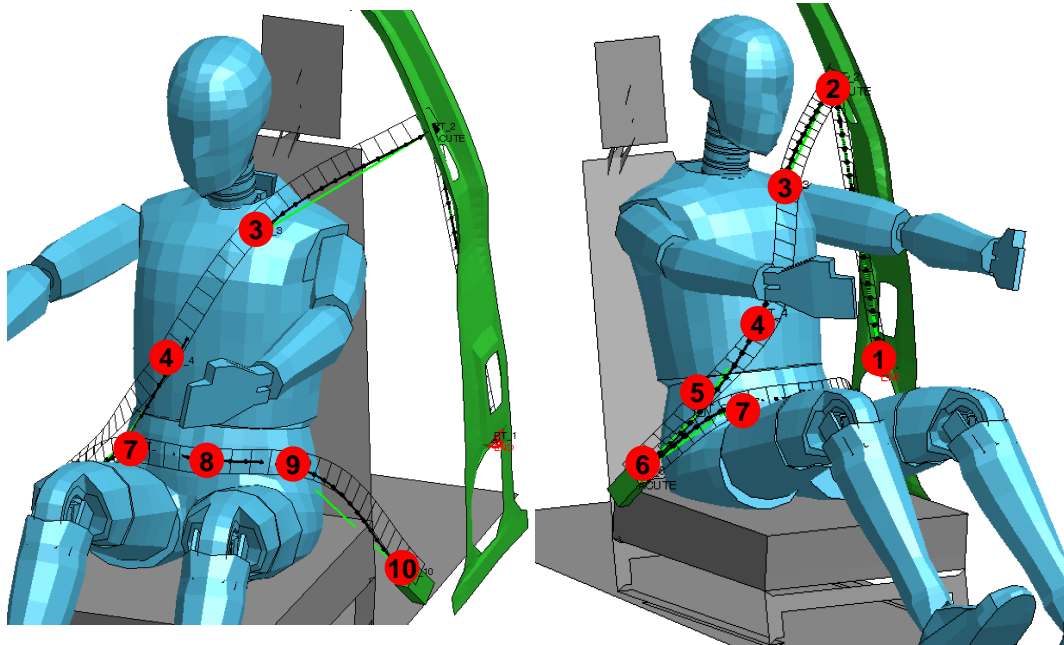
# Belt Fitting

- Next we need to define a path for the seatbelt
- Seatbelts => 2.Fit
- Press Define path



# Belt Fitting

- We now have to select a number of points to define the seatbelt path, by picking nodes.
- As the points are selected they appear as coordinates in the Seatbelt Menu



Seatbelts

1.Define -> 2.Fit -> 3.Mesh -> 4.Contact

Auto-refit Status Related items

Include: M1 <Master file>

Save Path definition: 11 point(s)

Ins bef Ins aft Translate Abort

Delete points Rotate

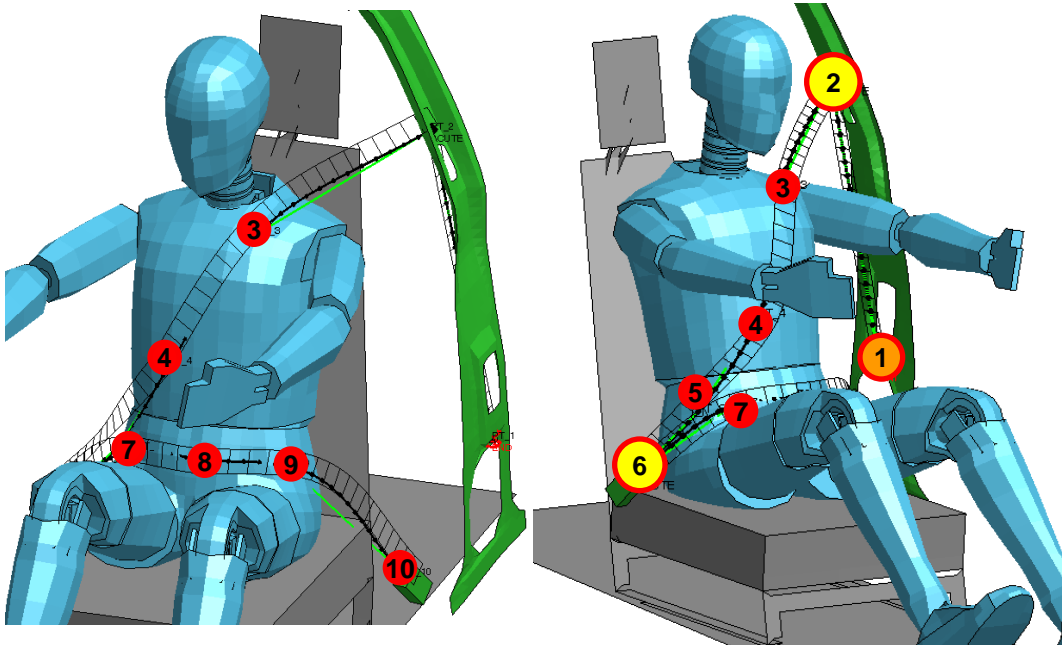
Modify coords Scale Reset all

Control twist Reflect Delete all

Point	Fix	Twist	X	Y	Z	Node
1	E	<input type="checkbox"/>	635.48	-214.02	292.63	1000537
2	A	<input type="checkbox"/>	713.39	-112.82	804.33	1000194
3	U	<input type="checkbox"/>	528.0	123.97	676.04	101940
4	U	<input type="checkbox"/>	405.15	240.51	484.33	102172
5	U	<input type="checkbox"/>	421.49	346.37	315.97	105692
6	A	<input type="checkbox"/>	448.09	450.11	204.59	1004333
7	U	<input type="checkbox"/>	386.37	300.93	330.88	105743
8	U	<input type="checkbox"/>	353.29	178.54	344.93	105437
9	U	<input type="checkbox"/>	421.49	53.626	315.97	105404
10	U	<input type="checkbox"/>	608.09	-50.113	34.592	10011730

# Belt Fitting

- Next we need to define some of the points to be a retractor (1) and slirings (2 & 6) so that they won't move during the seatbelt fitting (the end points are automatically fixed).
- Press on the 'U' or 'A' for the relevant point and select the relevant type



Seatbelts

1.Define -> 2.Fit -> 3.Mesh -> 4.Contact

Auto-refit Status Related items

Include: M1 <Master file>

Save Path definition: 11 point(s)

Ins bef Ins aft Translate Abort

Delete points Rotate

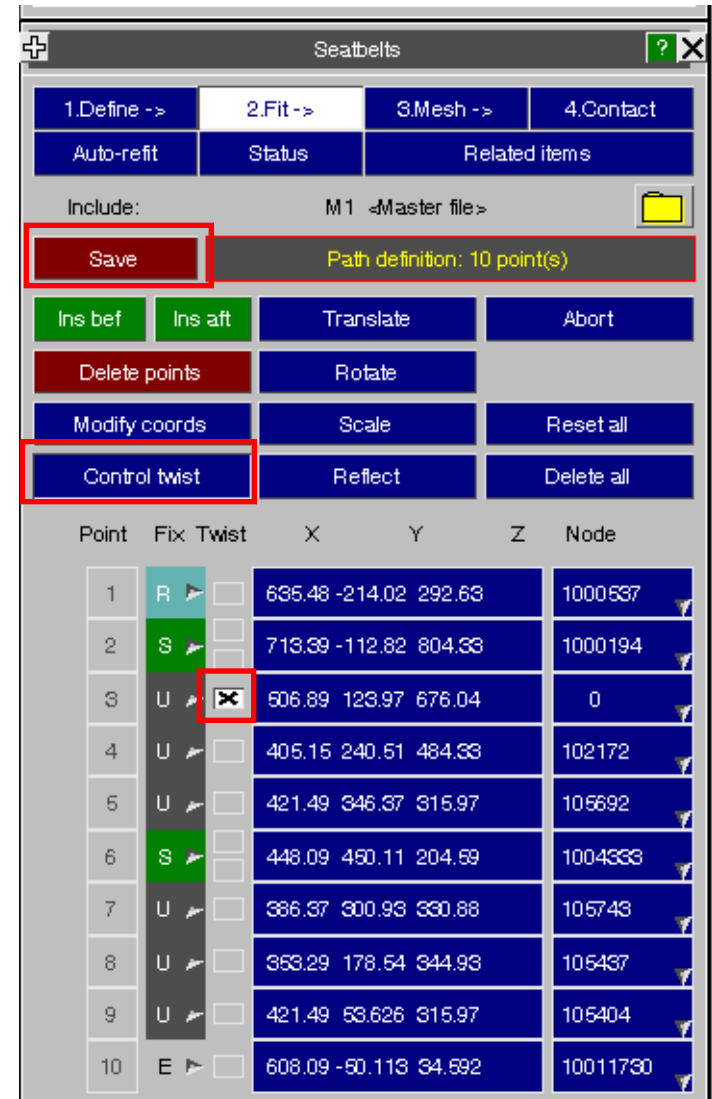
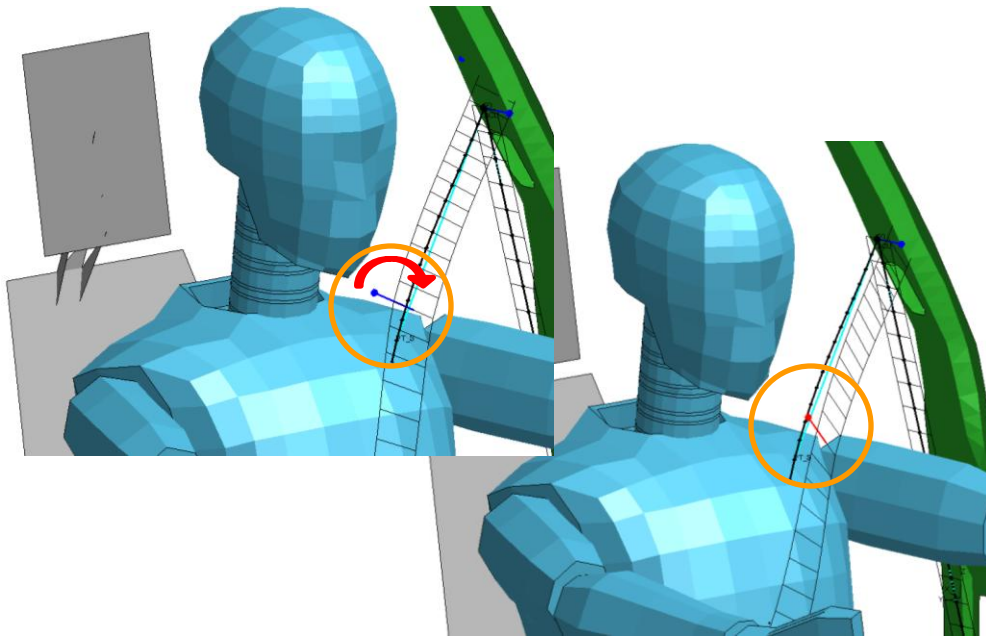
Modify coords Scale Reset all

Control twist Reflect Delete all

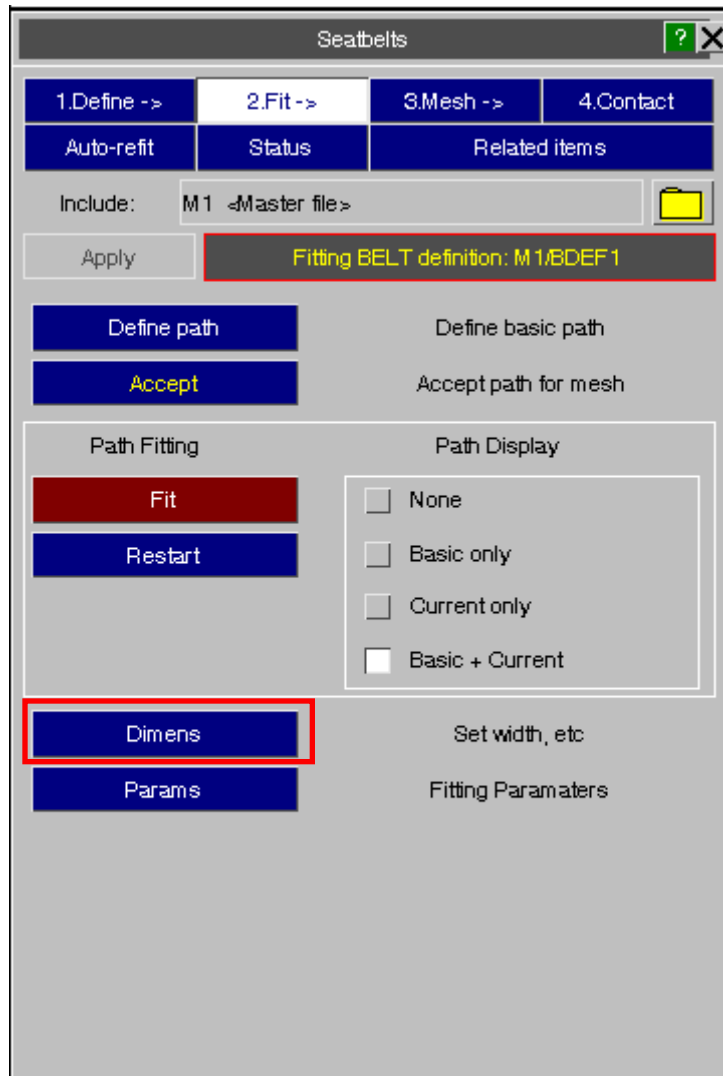
Point	Fix	Twist	X	Y	Z	Node
1	E		635.48	-214.02	292.63	1000537
2	A		Point fixity			1000194
3	U		U : Unfixed			101940
4	U		R : Retractor			102172
5	U		S : Slirping			105692
6	A		F : Fixed			1004333
7	U		K : Known position			105743
8	U		353.29	178.54	344.93	105437
9	U		421.49	53.626	315.97	105404
10	U		608.09	-50.113	34.692	10011730

# Belt Fitting

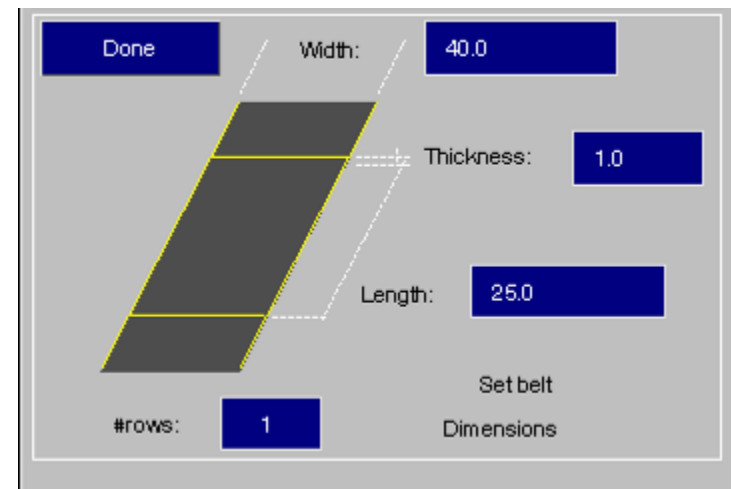
- The twist of the belt can also be controlled
- Press 'Control Twist' and a handle will appear at each point allowing the twist to be adjusted by clicking and dragging with the mouse.
- The twist can be removed by pressing on the 'x'
- Press 'Save'



# Belt Fitting

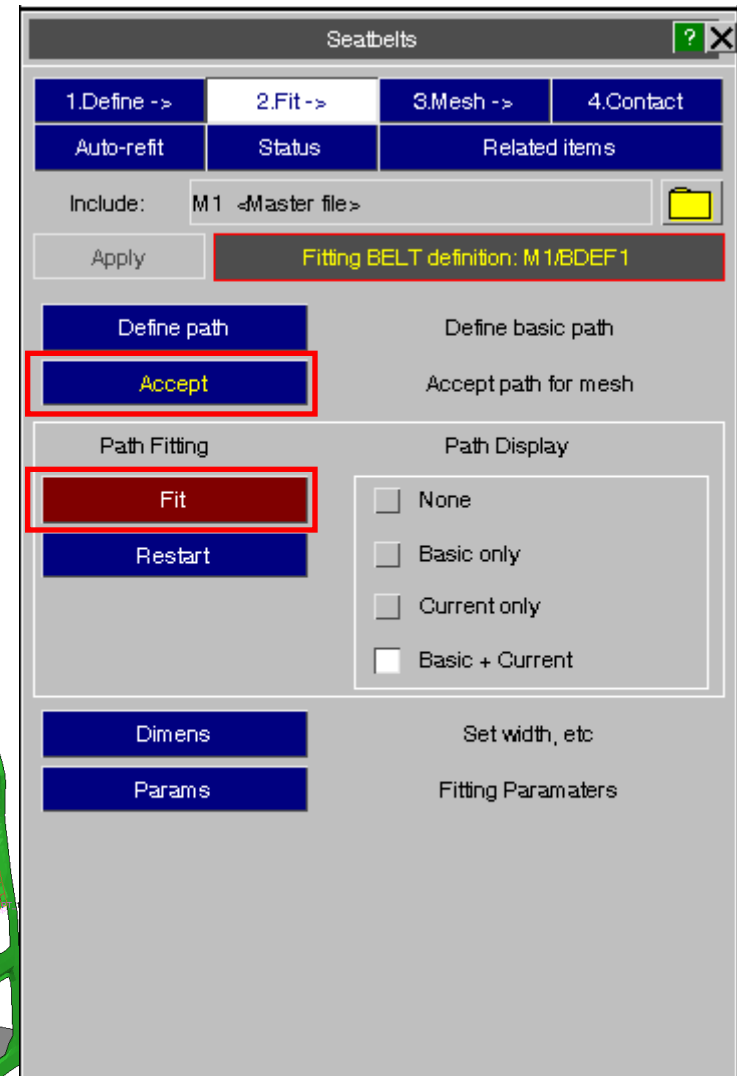
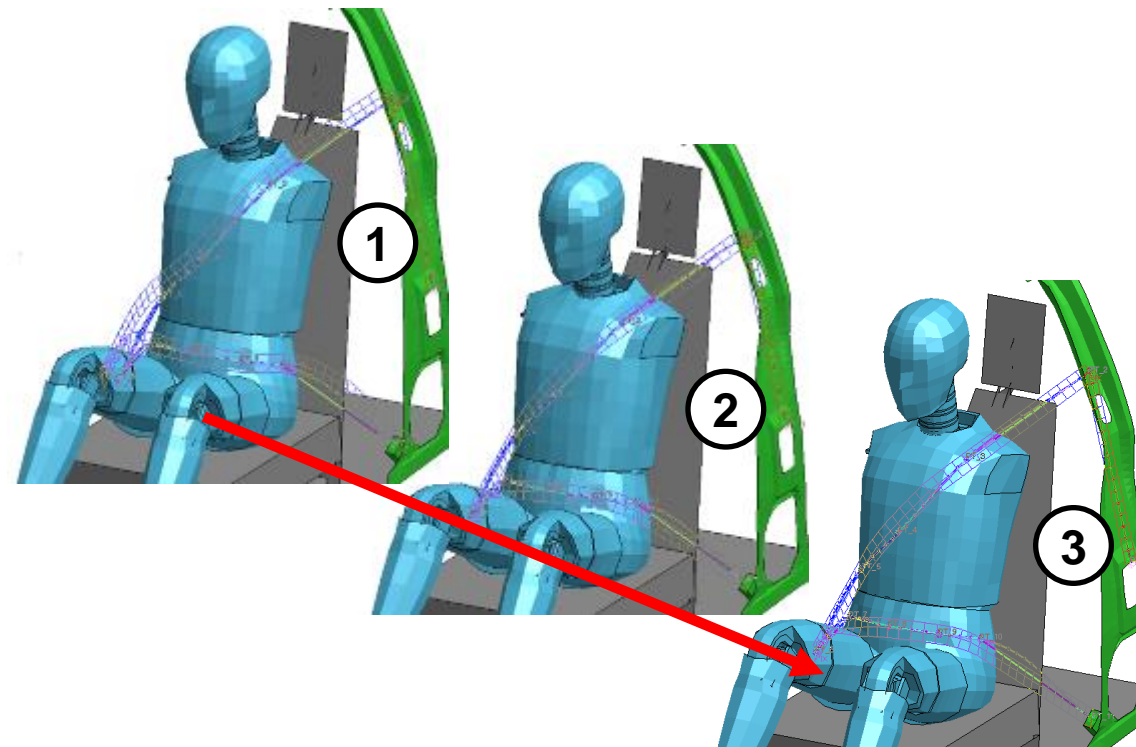


- Press Dimens; This opens the window in which we can define the dimensions of the seatbelt
- Width = 40mm
- Thickness = 3mm (to help prevent contact penetration)
- Length = 25mm
- #rows = 2 (number elements across the width of the belt)
- Press Done



# Belt Fitting

- Press Fit; To fit the seatbelt to the dummy
- This is an iterative process so you may need to press the button a couple of times (1-2) to get a good fit between the belt and dummy
- When you are happy with the fit press Accept



# Belt Fitting

- Next we need to create the seatbelt mesh
- Seatbelts=>3.Mesh
- First we need to define the seatbelt element properties
- 1D Sbelt props – is used to define the properties for the 1D \*Element\_Seatbelt
- 2D Sbelt props – is used to define the properties for the 2D \*Element\_Seatbelt
- Shell props – is used to define the properties for the 2D \*Element\_Shells



# Belt Fitting

MODIFY SEATBELT PROPERTY

Buttons: Abort Modify, Restore Original, Help, UPDATE\_PROPERTY, Copy Existing, Sketch, View Xrefs, Check Defn

Modify SEATBELT properties (model 1)

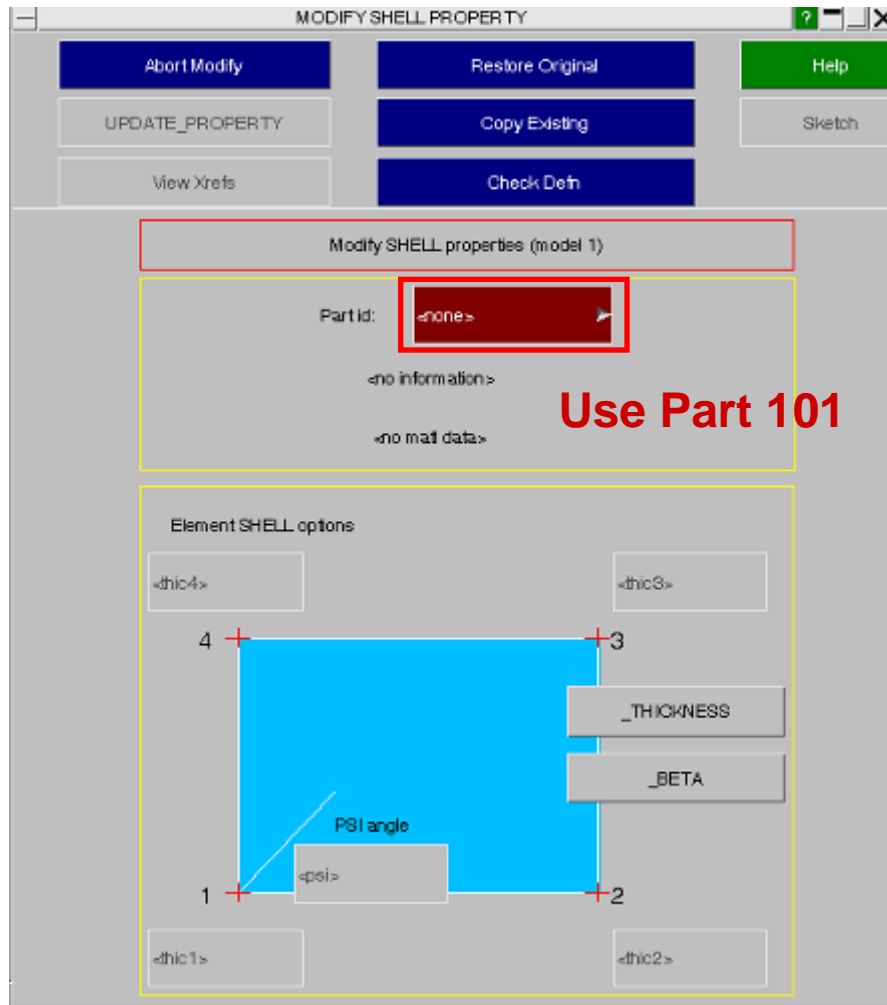
Partid: **<none>** **Use Part 100**

<no information>  
<no mail data>

Element SEATBELT options

Diagram: A horizontal line with three red '+' markers. The first marker is labeled '1' and the second is labeled '2'. Below marker '2' is the text 'Slack length:' and a blue box containing the value '0.0'.

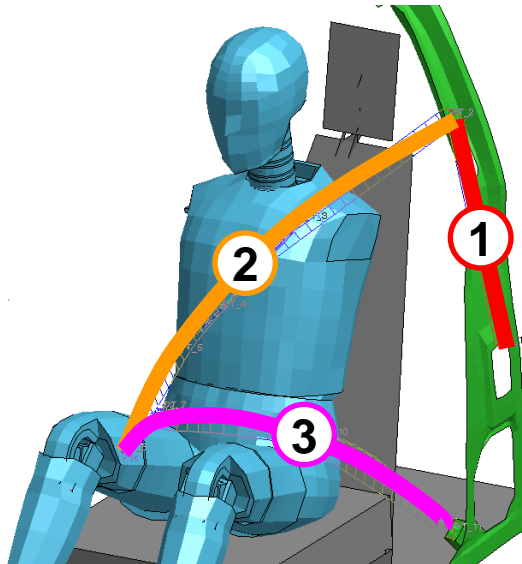
- Define the part into which the 1D \*Element\_Seatbelts are to be created
- Specify a Slack Length for the elements if required



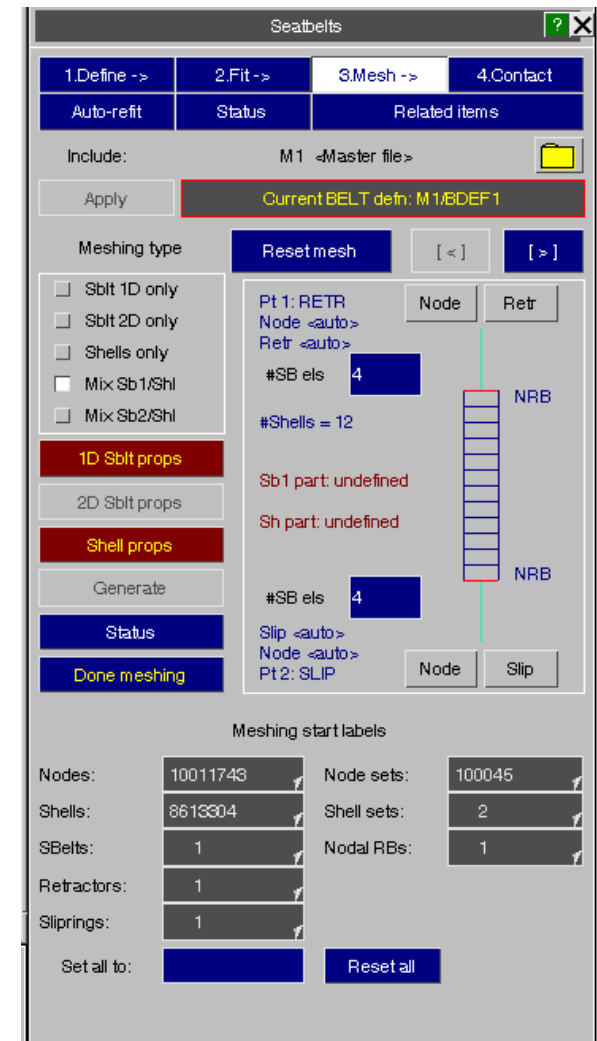
- Define the part into which the \*Element\_Shells are to be created

# Belt Fitting

- The belt is split up into sections that run between the end and sliprings/fixed points (in this model we have 3 sections)

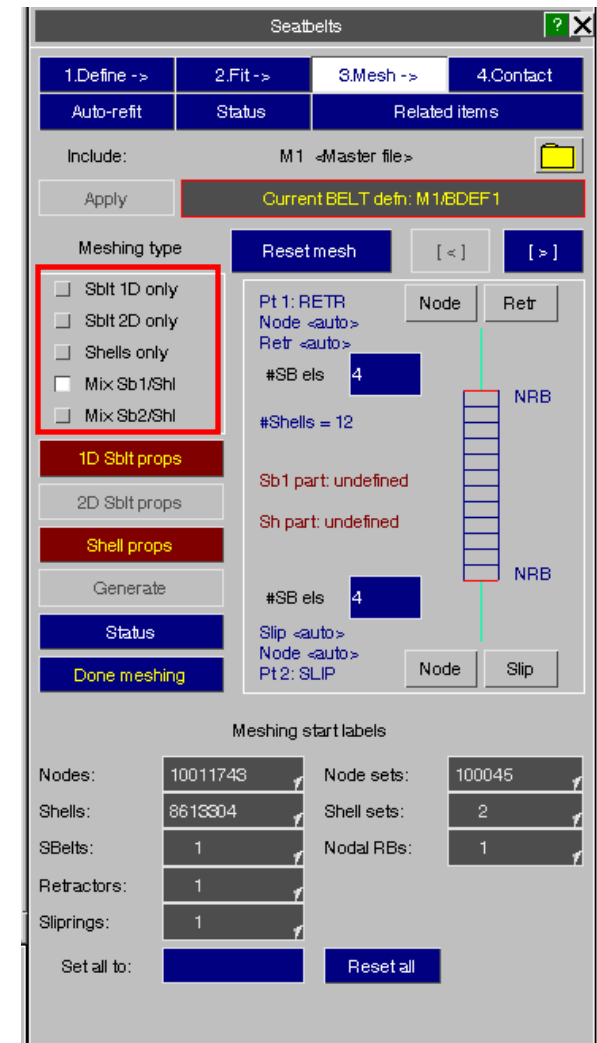


- For each of these section we need to define how we want the belt to be meshed



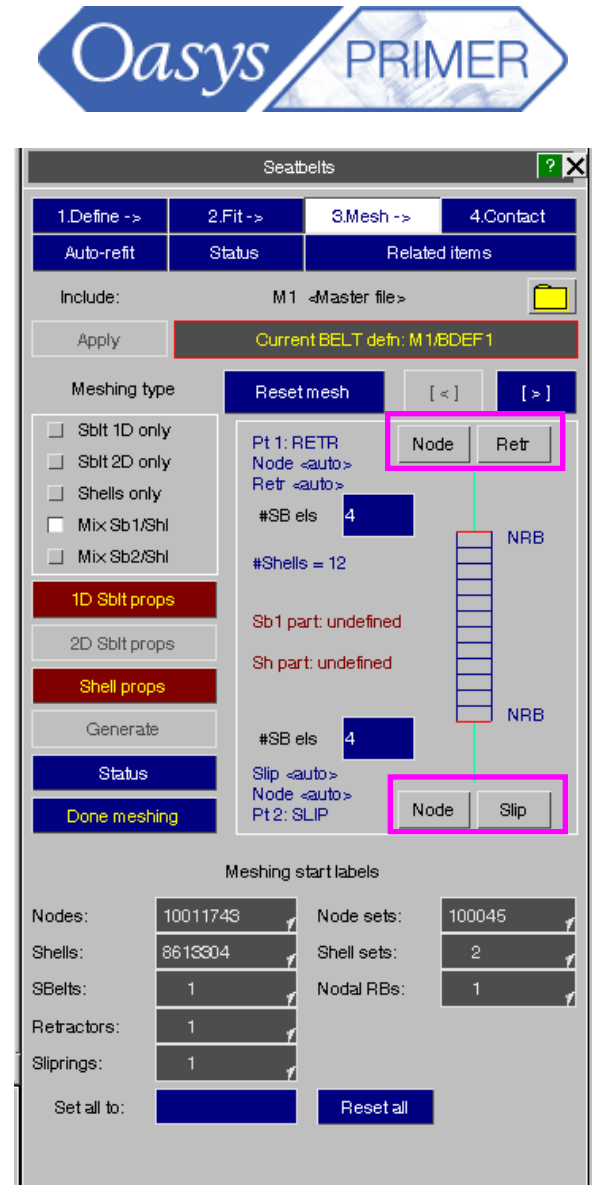
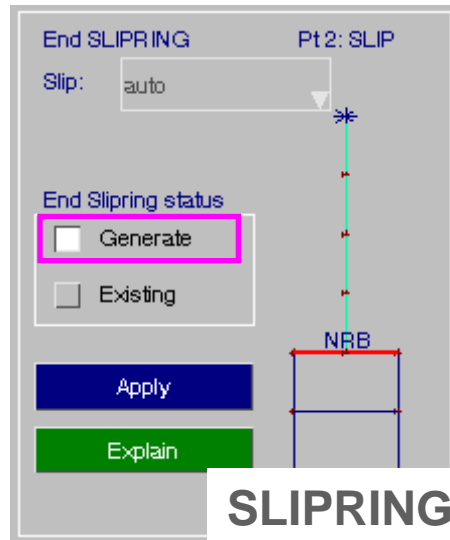
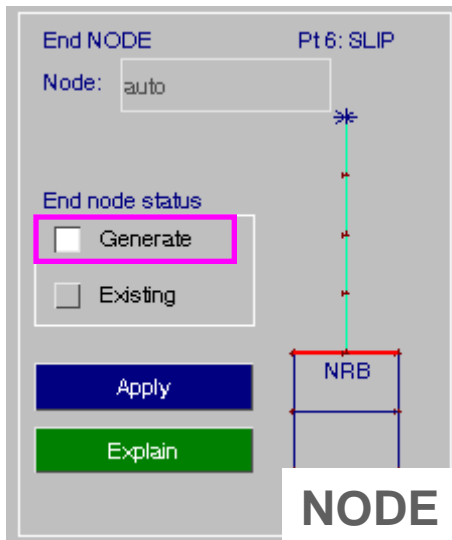
# Belt Fitting

- There are five options to choose from
  1. 1D \*Element\_Seatbelt only
  2. 2D \*Element\_Seatbelt only
  3. \*Element\_Shell only
  4. 1D \*Element\_Seatbelt at each end and \*Element Shell in the middle
  5. 2D \*Element\_Seatbelt at each end and \*Element Shell in the middle
- Only the sections that are in contact with the dummy need to be meshed with shell elements (use Option 3,4 or 5)
- Elements connecting to a slipping or retractor need to be 1D or 2D\*Element\_Seatbelt. (use Option 1,2,4 or 5)



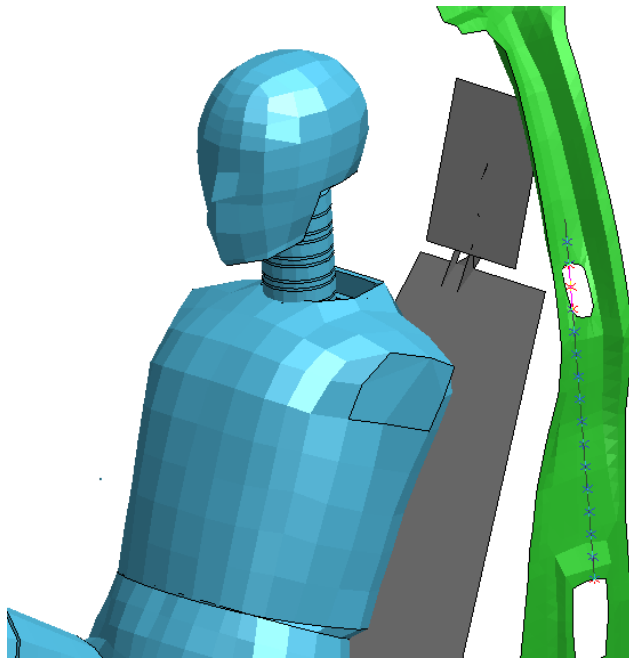
# Belt Fitting

- The end fixing node, retractor and slipping setup can also be controlled.
- These can either be generated automatically by PRIMER or the user can specify a particular node, retractor or slipping.
- In this tutorial we will use the automatic PRIMER option

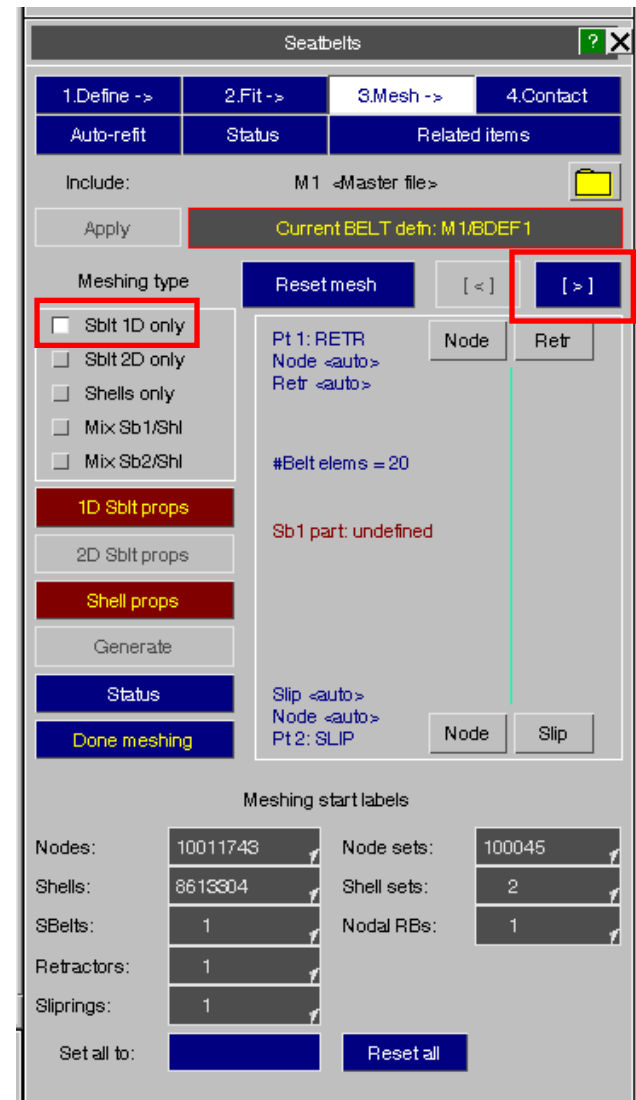


# Belt Fitting

- The first section isn't in contact with the dummy so it doesn't need to be meshed using any shell elements

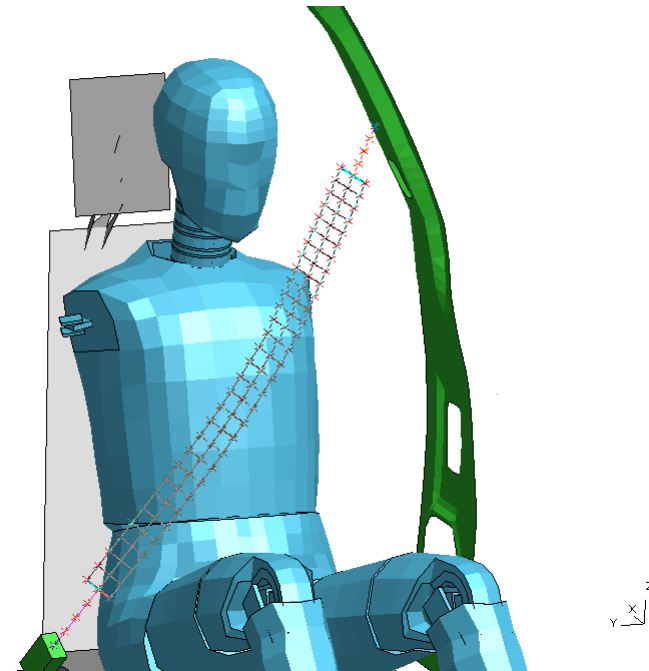


- Press the Arrow button to move onto the next section



# Belt Fitting

- The second section is in contact with the dummy need to be meshed using some shell elements
- It also needs to go through sliprings at either end so it need to meshed as a mixture of seatbelt and shell elements
- Typically 3 to 4 seatbelt elements at the ends are need to allow for them to flow through the slipring



Seatbelts

1.Define -> 2.Fit -> 3.Mesh -> 4.Contact

Auto-refit Status Related items

Include: M1 <Master file>

Apply Current BELT defn: M1/BDEF1

Meshing type

☐ Sbelt 1D only

☐ Sbelt 2D only

☐ Shells only

☒ Mix Sb1/Shl

☐ Mix Sb2/Shl

1D Sbelt props

2D Sbelt props

Shell props

Generate

Status

Done meshing

Reset mesh

[ < ]

[ > ]

Pt 2: SLIP

Node <auto>

Slip <auto>

#SB els 4

#Shells = 29

Sb1 part: undefined

Sh part: undefined

#SB els 4

Slip <auto>

Node <auto>

Pt 6: SLIP

Node

Slip

NRB

NRB

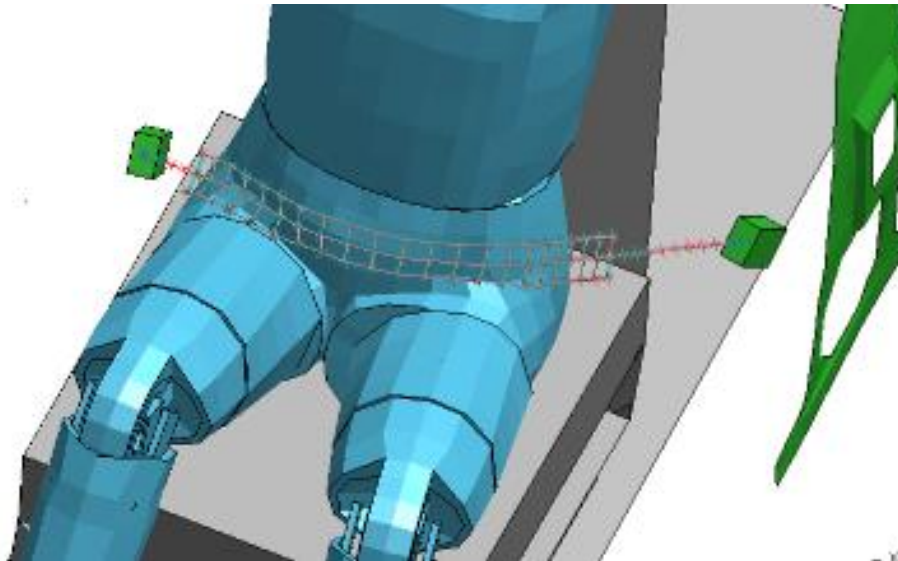
Meshing start labels

Nodes:	10011743	Node sets:	100045
Shells:	8613304	Shell sets:	2
SBelts:	1	Nodal RBs:	1
Retractors:	1		
Sliprings:	1		

Set all to: Reset all

# Belt Fitting

- The third section is in contact with the dummy need to be meshed using some shell elements
- It also needs to go through a slipping at one end so it should be meshed as a mixture of seatbelt and shell elements
- Once the belt is no longer in contact with the dummy is doesn't need to be meshed as shell elements



Seatbelts

1.Define -> 2.Fit -> 3.Mesh -> 4.Contact

Auto-refit Status Related items

Include: M1 <Master file>

Apply Current BELT defn: M1/BDEF1

Meshing type

Reset mesh [ < ] [ > ]

☐ Sb1t 1D only  
☐ Sb1t 2D only  
☐ Shells only  
☒ Mix Sb1/Shl  
☐ Mix Sb2/Shl

1D Sb1t props  
2D Sb1t props  
Shell props  
Generate  
Status  
Done meshing

Pt 6: SLIP  
Node <auto>  
Slip <auto>  
#SB els 4  
#Shells = 19  
Sb1 part: undefined  
Sh part: undefined  
#SB els 10  
Node <auto>  
Pt 10: END

Node Slip  
NRB  
NRB

Meshing start labels

Nodes:	10011743	Node sets:	100045
Shells:	8613304	Shell sets:	2
SBelts:	1	Nodal RBs:	1
Retractors:	1		
Sliprings:	1		

Set all to: Reset all

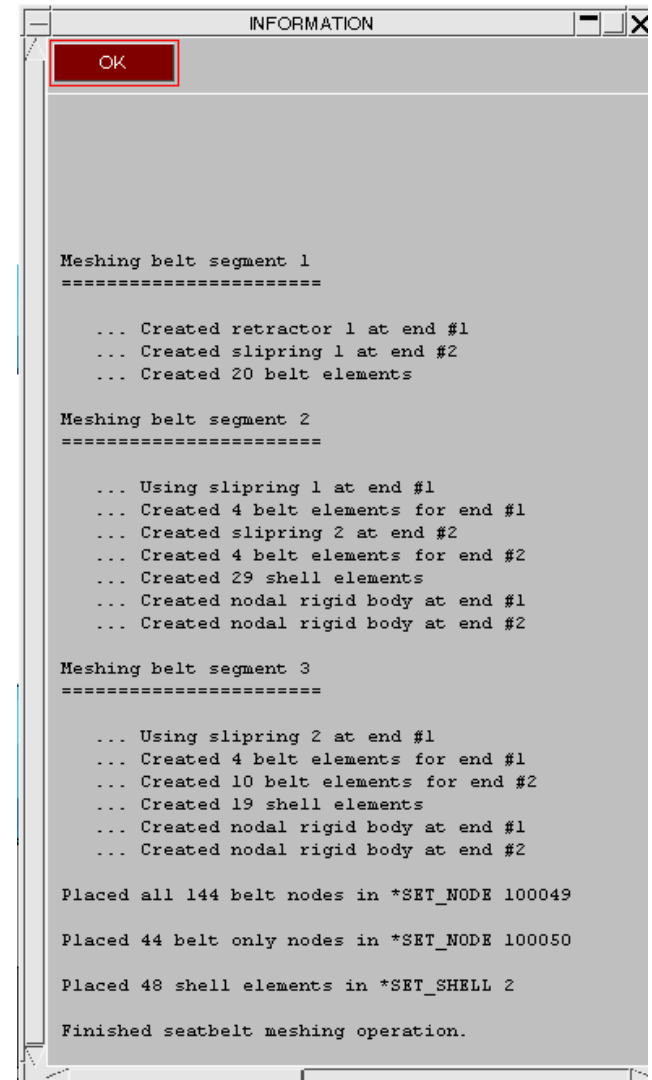
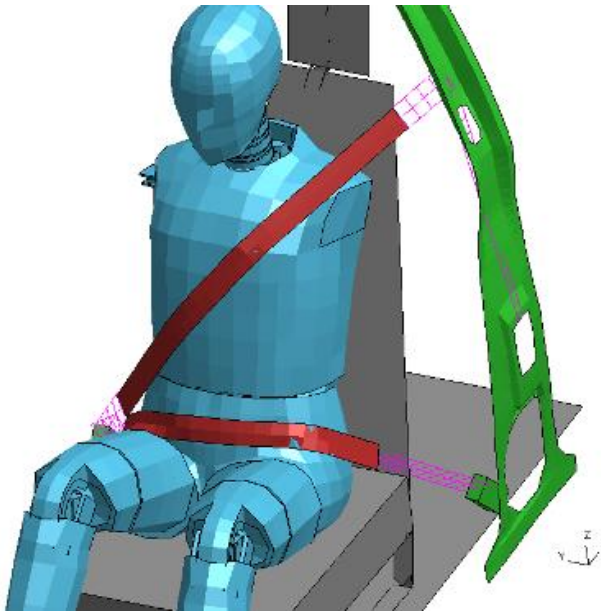
# Belt Fitting

- The numbering for the new nodes and elements can also be controlled from this menu

A screenshot of the "Seatbelts" software interface. The window has a title bar "Seatbelts" with a question mark and close button. Below the title bar are four tabs: "1.Define ->", "2.Fit ->", "3.Mesh ->" (which is active), and "4.Contact". Under the tabs are three buttons: "Auto-refit", "Status", and "Related items". Below these is an "Include:" field with "M1 <Master file>" and a folder icon. An "Apply" button is next to it. A red box highlights the text "Current BELT defn: M1/BDEF1". Below this is a "Meshing type" section with a list of checkboxes: "Sbit 1D only", "Sbit 2D only", "Shells only", "Mix Sb1/Shl", and "Mix Sb2/Shl". To the right of these are buttons for "1D Sbit props", "2D Sbit props", "Shell props", "Generate", "Status", and "Done meshing". Further right is a "Reset mesh" button and navigation buttons "[ < ]" and "[ > ]". Below the checkboxes is a diagram showing a vertical stack of 19 elements, with "Node" and "Slip" labels. To the right of the diagram are fields for "#SB els" (set to 4), "#Shells = 19", "Sb1 part: undefined", "Sh part: undefined", "#SB els" (set to 10), "Node <auto>", "Pt 6: SLIP", "Node <auto>", "Slip <auto>", "Node", and "Pt 10: END". At the bottom, a red box highlights the "Meshing start labels" section, which contains a table of values for Nodes, Shells, SBelts, Retractors, Sliprings, Node sets, Shell sets, and Nodal RBs, along with a "Reset all" button.

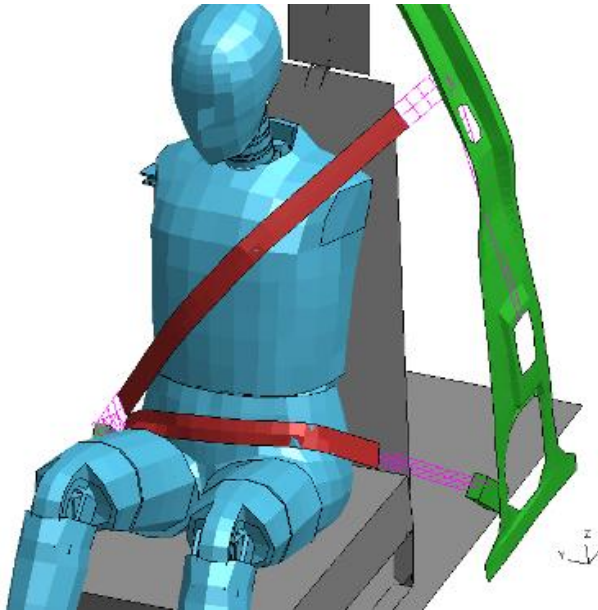
# Belt Fitting

- Now press Generate to create the mesh
- A window will come up detailing the elements that will be created
- Press OK and PRIMER will create the elements



# Belt Fitting

- A check screen will then appear detailing the status of the newly created elements.
- There will be some errors for the retractor as we have not yet set the properties for this element.
- Press on 'Retractor' to edit the element.



Seatbelts

1.Define -> 2.Fit -> 3.Mesh -> 4.Contact

Auto-refit Status Related items

Include: M1 <Master file>

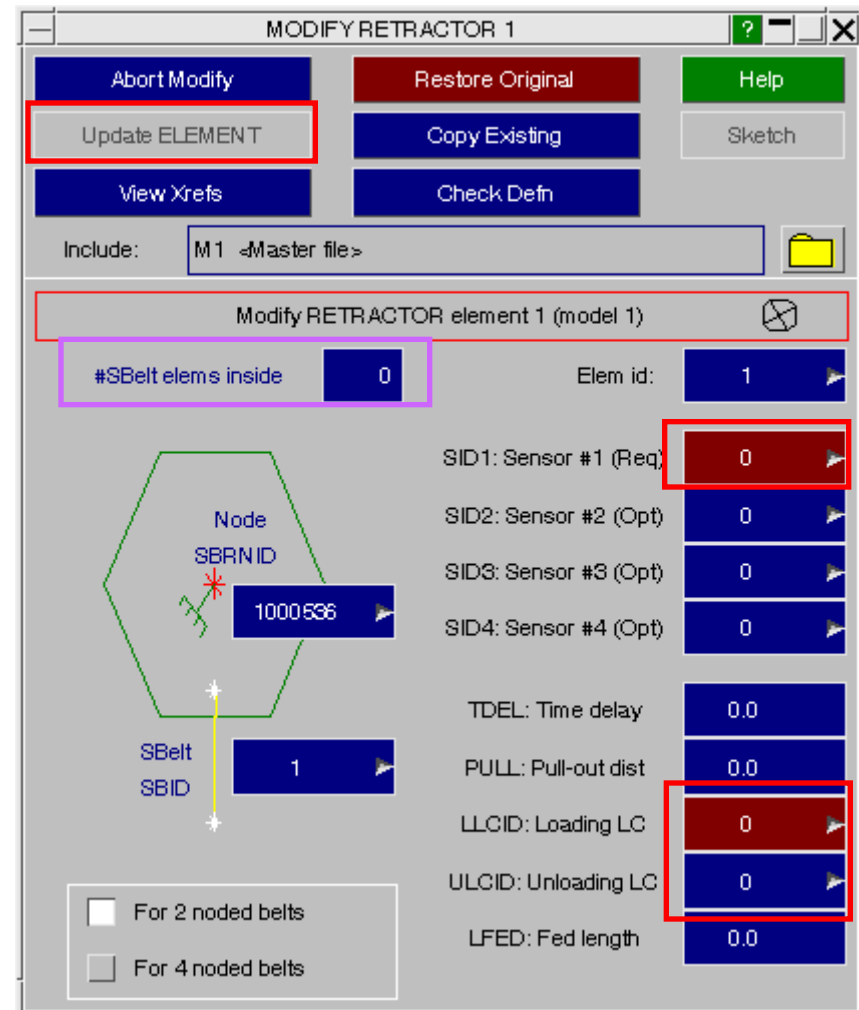
Apply Current BELT defn: M1/BDEF1

Status of meshed items (click to edit) Explain

Meshed item	Check status
1D SB Part	100: Checks ok
1D SB Sect	1000010: Checks ok
1D SB Matl	100: Checks ok
2D SB Part	}
2D SB Sect	} Not used in mesh
2D SB Matl	}
Shell Part	101: Checks ok
Shell Sect	1000011: Checks ok
Shell Matl	1000008: Checks ok
<b>Retractor</b>	1: 2 error(s) and 1 warning(s)
Slipring	1: Checks ok
Slipring	2: Checks ok

# Belt Fitting

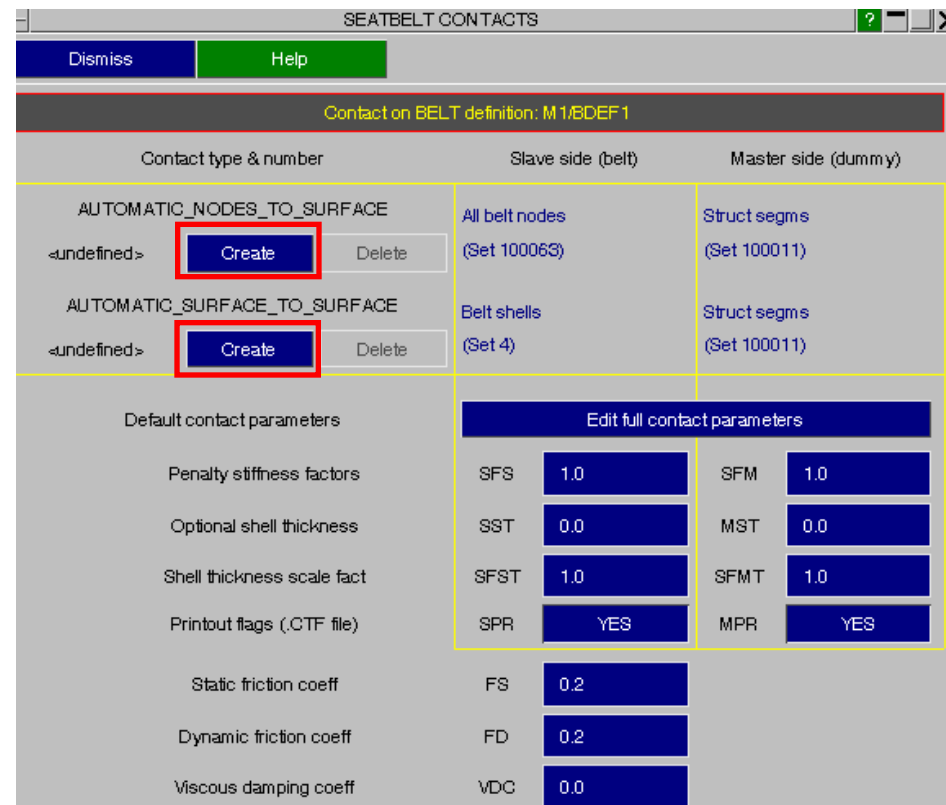
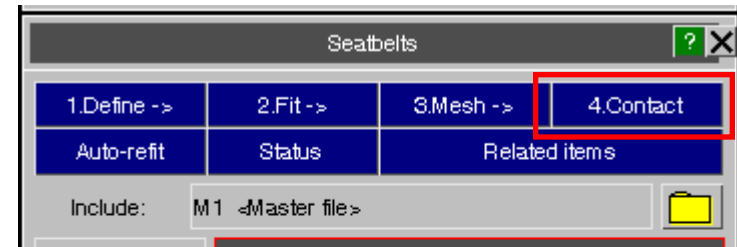
- For sensor 1 (SID1) select sensor 1
- For the loading curve (LLCID) select curve 10
- For the unloading curve (ULCID) select curve 10
- You can also set the number of seat belt elements stored inside the retractor
- Press 'Update ELEMENT'



# Belt Fitting



- Next we need to define the contact between the belt and the dummy.
- Seatbelts => 4.Contact
- We can create two contacts
  - \*Contact\_Automatic\_Node\_to\_Surface between the node on the belt elements and the dummy
  - \*Contact\_Automatic\_Surface\_to\_Surface between the shell elements and the dummy
- Typical only the contact between the shell elements and the dummy is created.
- The dummy side of the contact will only include those parts selected at the start of the seatbelt definition
- Press Create button to make the relevant contacts



- We have now finished seatbelt definition.

## Tips on avoiding Initial Penetrations when fitting the seatbelt

- Add a factor to the true thickness of the belt elements
  - i.e. enter a number > real thickness in the seatbelt Dimens window (see Slide 9)
  - In the analysis, high belt forces & penetration may cause you to thicken the contact surface anyway.
- Avoid too many pushes of the FIT button
  - About 1 - 2 times should be enough
  - use visual inspection to check the fit rather than just pressing the button a lot of times.
- Try a different path, or moving the existing points.
- As a last resort, move the penetrating nodes with ORIENT.

This material model is used for \*Element\_Seatbelt parts.

Card 1	1	2	3	4	5	6	7	8
Variable	MID	MPUL	LLCID	ULCID	LMIN			
Type	A8	F	I	I	F			
Default	0	0.	0	0	0.0			

- MID – Material ID
- MPUL – Mass per unit length
- LLCID – Load curve for belt loading (Force vs Engineering Strain)  
Take the material stress-strain curve and multiply by the belt cross sectional area.
- ULCIN – Unload curve for belt loading (Force vs Engineering Strain). Same as loading curve for elastic behaviour
- LMIN – Minimum Length, Used to determine when an element goes in or out of a retractor, or through a slipping (typically about 5mm)

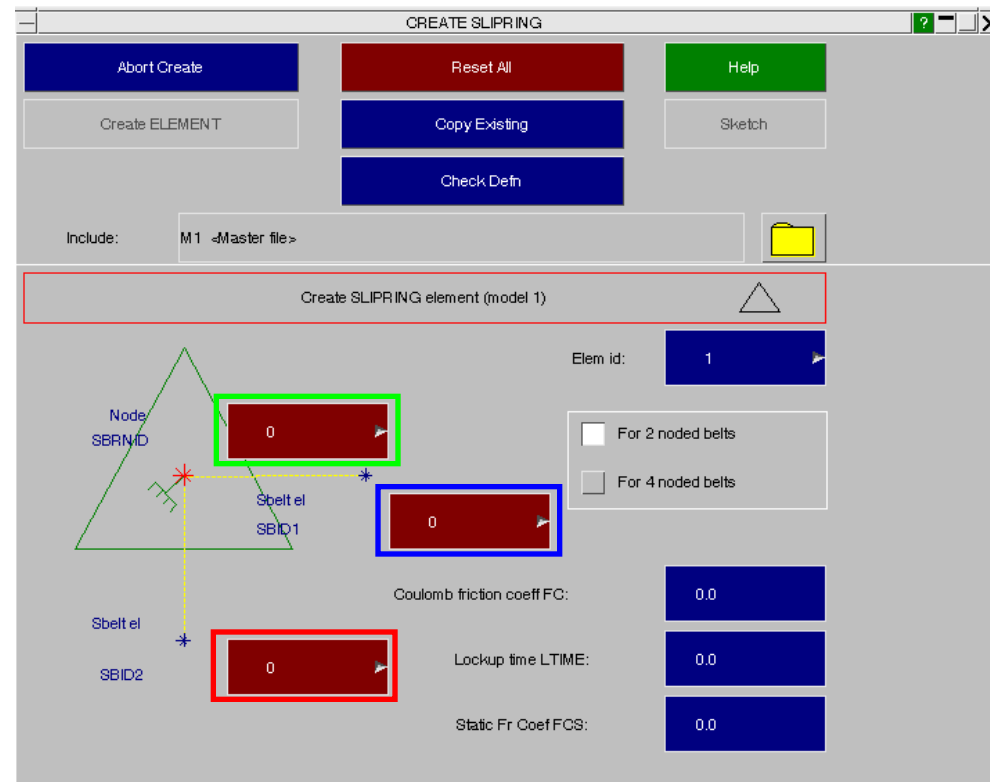
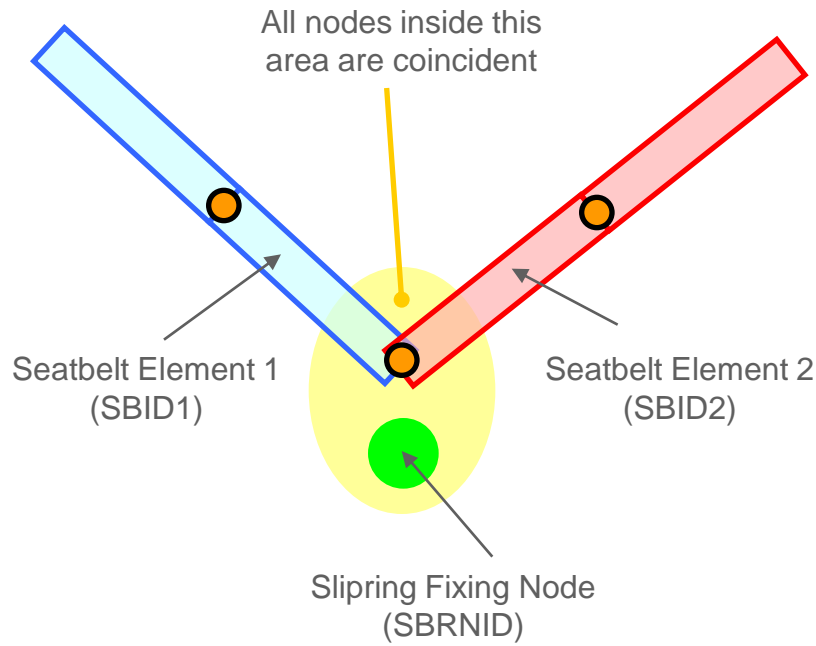
# Sliprings (\*Element\_Seatbelt\_Slipring)

The Slipring element is fixed to the vehicle structure and allows seatbelt elements to flow through it

Card	1	2	3	4	5	6	7	8
Variable	SBSRID	SBID1	SBID2	FC	SBRNID	LTIME	FCS	
Type	I	I	I	F	I	F	F	
Default	0	0	0	0.0	0	1.0E20	0.0	
Remarks	1	1	1	yes	yes			

- SBSRID – Slipring Element ID
- SBID1 – ID of \*Element\_Seatbelt on one side of the slipring
- SBID2 – ID of \*Element\_Seatbelt on the other side of the slipring
- FC – Dynamic Friction coefficient
- SBRNID – Slipring Node ID (fixing node attached to the vehicle structure)
- LTIM – Lock up time
- FCS – Optional Static Friction coefficient

# Sliprings (\*Element\_Seatbelt\_Slipring)



- Seatbelt Element 1 and Seatbelt Element 2 share the same node
- The Slipring fixing node (SBRNID) is coincident with but not connected to the node on Seatbelt Element 1 and Seatbelt Element 2
- Typically the slipring fixing node is on the structure of the vehicle or connected to it with a constraint (e.g. Nodal Rigid Body)

The Retractor element has two states: unlocked and locked.

- When unlocked the seatbelt elements are paid out or taken in at a constant fixed tension
- When locked the belt is paid out according to the user defined force-pull out relationship
- switching from unlocked to locked is controlled by the sensors referred to on the Retractor card.

A number of seatbelt elements can be pre-stored inside the retractor to be paid out during the analysis. These elements can be automatically created for you by PRIMER when you create the retractor element.

- The elements are all zero length and the nodes are coincident with the retractor node
- On the \*Element\_Seatbelt card the SBRID variable is set to the retractor element ID

# Retractor (\*Element\_Seatbelt\_Retractor)

Card 1	1	2	3	4	5	6	7	8
Variable	SBRID	SBRNID	SBID	SID1	SID2	SID3	SID4	
Type	I	I	I	I	I	I	I	
Default	0	0	0	0	0	0	0	
Remarks		1,2	2	3				

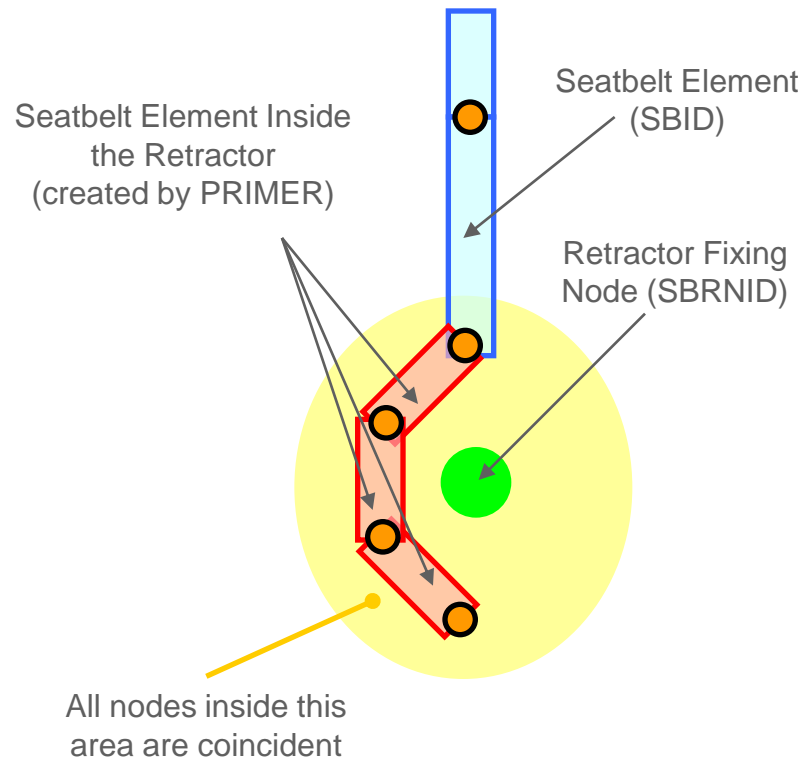
- SBRID – Retractor Element ID
- SBRNID – Retractor Node ID (fixing node attached to the vehicle structure)
- SBID – ID of \*Element\_Seatbelt connected to the retractor
- SID1 – SID4 – Sensor IDs that control when the retractor should lock

Card 2

Variable	TDEL	PULL	LLCID	ULCID	LFED			
Type	F	F	I	I	F			
Default	0.0	0.0	0	0	0.0			
Remarks			4	5				

- TDEL – Time delay after sensor firing before locking the retractor
- PULL – Length of belt to pay out between time delay and locking
- LLCID – Load curve for loading (Force vs Pull Out Length)
- ULCID – Load curve for unloading (Force vs Pull Out Length)
- LFED – Element Feed Length

# Retractor (\*Element\_Seatbelt\_Retractor)



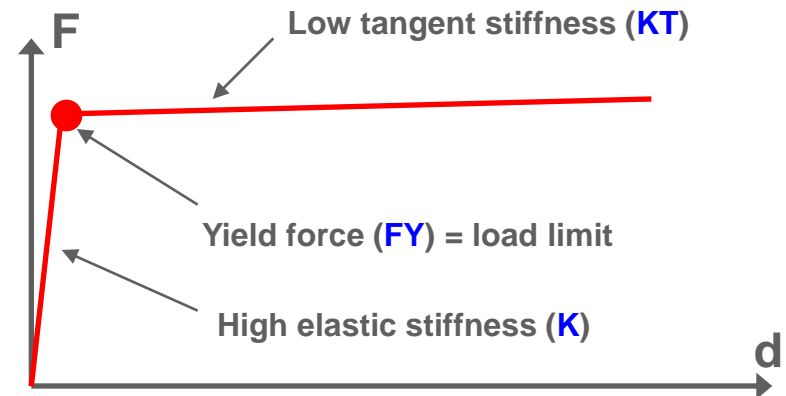
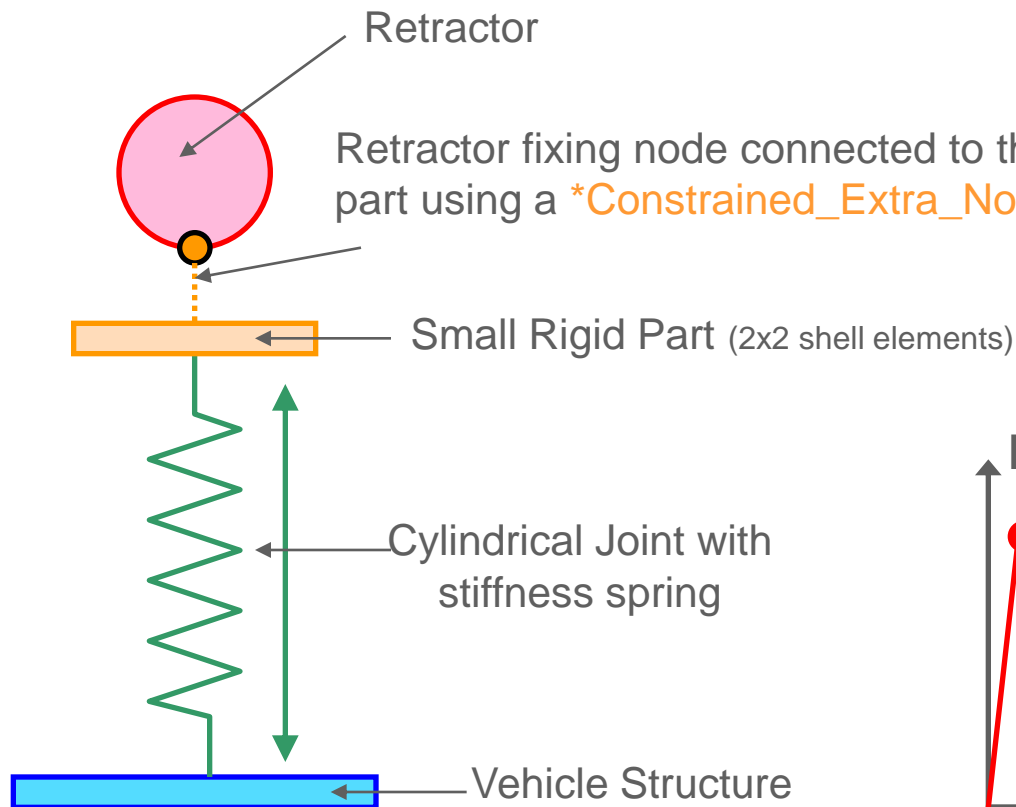
The screenshot shows the 'CREATE RETRACTOR' dialog box. The 'Include:' field is set to 'M1 <Master file>'. The 'Create RETRACTOR element (model 1)' section is active. The '#SBelt elems inside' field is set to 5. The 'Elem id:' field is set to 1. The 'SID1: Sensor #1 (Req)' field is set to 0. The 'SID2: Sensor #2 (Opt)' field is set to 0. The 'SID3: Sensor #3 (Opt)' field is set to 0. The 'SID4: Sensor #4 (Opt)' field is set to 0. The 'TDEL: Time delay' field is set to 0.0. The 'PULL: Pull-out dist' field is set to 0.0. The 'LLCID: Loading LC' field is set to 0. The 'ULCID: Unloading LC' field is set to 0. The 'LFED: Fed length' field is set to 0.0. The 'SBelt SBID' field is set to 45. The 'Node SBRNID' field is set to 0. The 'For 2 noded belts' checkbox is unchecked. The 'For 4 noded belts' checkbox is checked.

- The Retractor fixing node (SBRNID) is coincident with but not connected to the nodes of the seatbelt element (SBID) and all the seatbelt elements stored in the retractor
- A least one sensor must be referred to. If the retractor should start the analysis locked then use a time base (SBTYP = 3) sensor and set the Time = 0.0sec.

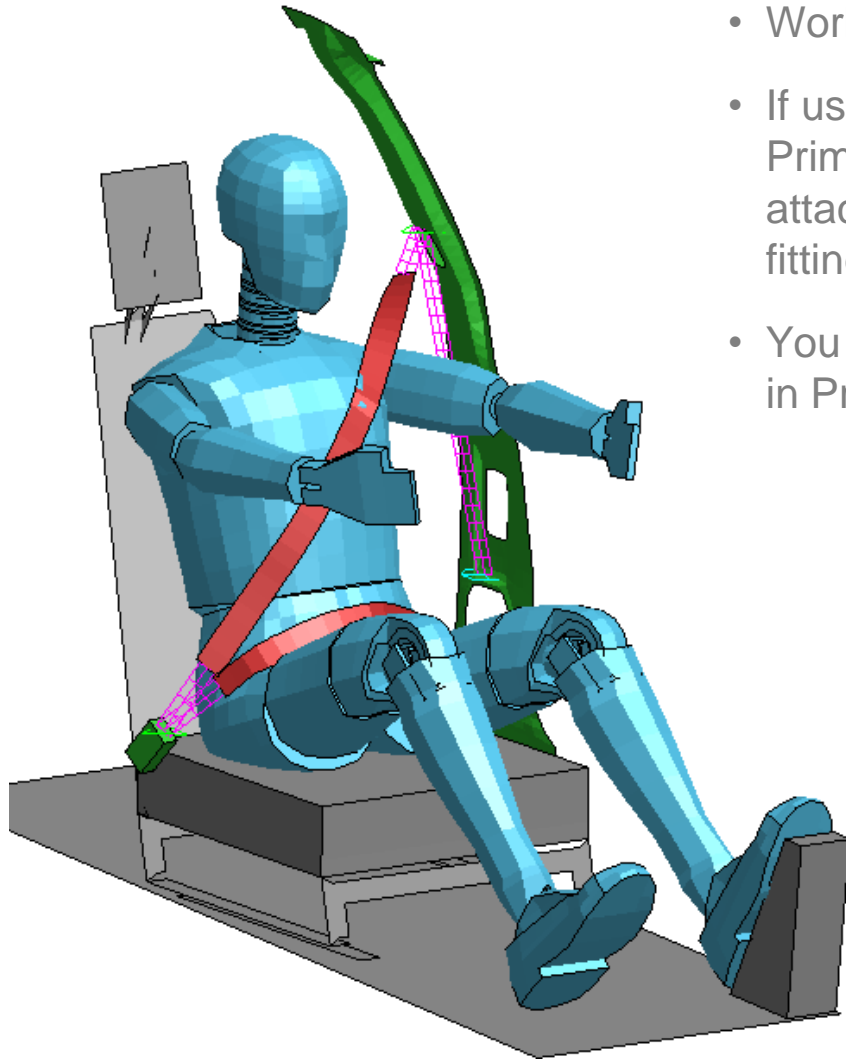
The pretensioner element can behave in a number of different ways depending on which type (SBPRTY) is specified on the element card.

- Type 1 & 5 – represent pyrotechnic devices that spin the spool of the retractor
- Type 2 & 3 – represent pre-loaded springs / torsion bars (using discrete elements)
- Type 4, 6 & 7 – allow a particular force behaviour to be defined

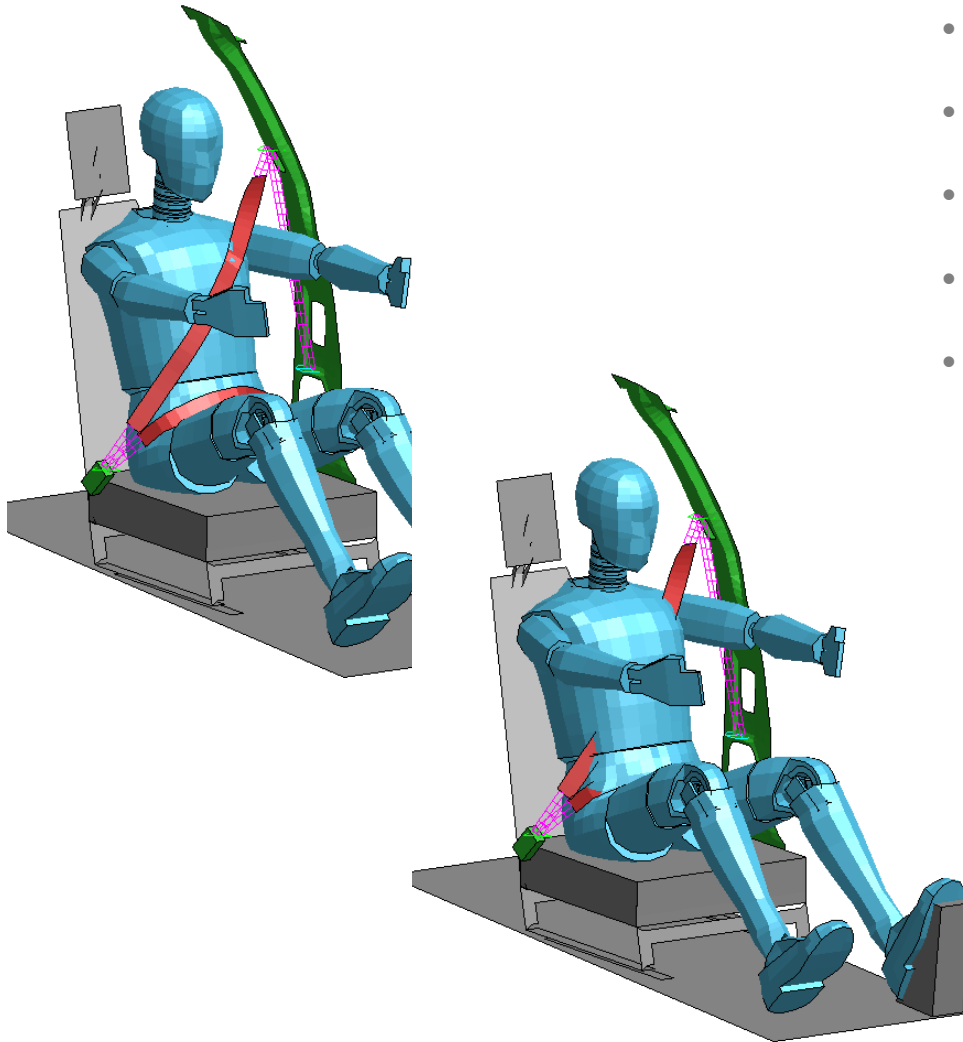
A load limiter is typically modelled using an elastoplastic spring (**\*MAT\_S03**) between the retractor and the vehicle structure. A cylindrical joint is also needed to prevent the retractor from drifting.



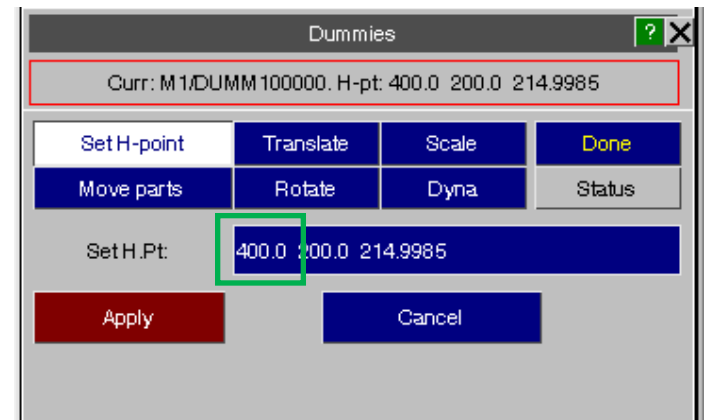
# Seat Belt Re-Fitting



- Works only if belt was initially fitted in Primer.
- If using a belt model created in previous versions of Primer, check carefully for redundant seatbelt elements attached to retractor and/or slings after the first re-fitting of the belt.
- You may find it necessary to re-create the belt definition in Primer 9.4 for this feature to work properly.



- Reposition the dummy
- Tools => Dummies
- Position => Set H Point
- Move the dummy 20mm in x (420 to 400)
- Press 'Apply'



# Belt Re-fitting

- Tools => Occupant => Seatbelt
- Press 'Auto-refit'
- Press 'Appy'
- PRIMER will update the belt path using the new geometry and create a new belt

